

## **Industry Topics and 2023 NEC 8 HR CE Outline**

### **Lesson 1: Electrical Safety**

**-1 Hour**

- I. Electrical Hazards
  - A. Introduction
  - B. OSHA
- II. Advantages of an Electrical Safety Program
- III. Recognition of Hazards
- IV. Key Terminology & Definitions
- V. How Materials and substances affect the Flowing of Electricity
  - A. Various Materials
  - B. Water
- VI. The Primary Causes of Electrical Shock
- VII. The Effects of Shock on the Body
- VIII. Low Voltage Risks
- IX. High Voltage
- X. Static Electricity
- XI. Overload Hazards
- XII. Protective Measures
  - A. Insulation
  - B. Guarding
  - C. Grounding
  - D. Circuit Protection Devices

- E. Safe Work Practices
  - F. Protection from Energized Parts
  - G. Protection from Unexpected Startup
  - H. Protection from Overhead Power Lines
  - I. Personal Protective Equipment
- XIII. Training Requirements

## **Lesson 2: Cost Estimating for Electrical Projects**

### **-1 Hour**

- I. Overview
  - A. List of all 9 main topics
- II. Electrical Cost Estimators
  - A. Summary of Electrical Cost Estimators
- III. Pick the Best Project to Bid On
  - A. Summary of Pick the Best Project to Bid On
  - B. Visit the Prospective Worksite
  - C. Fees and Permits
  - D. Costs of Electrical Bidding Labor
  - E. Software for Electrical Estimating
- IV. Review the Requirements
  - A. Summary of Review the Requirements
- V. Study the Illustrations
  - A. Summary of Study the Illustrations
  - B. Conflict Between Illustrations and Specifications

- VI. Put a Quantity Takeoff in Action
  - A. Summary of Put a Quantity Takeoff in Action
- VII. Get Quotes From Suppliers
  - A. Summary of Get Quotes From Suppliers
- VIII. Make an Estimate
  - A. Summary of Make an Estimate
- IX. Include Profit and Overhead
  - A. Summary of Include Profit and Overhead
- X. Create a Proposal
  - A. Summary of Create a Proposal
  - B. Lump Sum Bids
  - C. Cost Plus Contracts
  - D. Material and Time Contracts
  - E. Change Order
- XI. Electrical Estimating Software
  - A. Summary of Electrical Estimating Software
- XII. Bid Submission
  - A. Summary of Bid Submission
  - B. Tips to Winning Project Bids
    - 1. Understanding the Bidding Process
    - 2. Bid Quickly
    - 3. Estimate Costs Accurately
    - 4. Bid on Correct Projects

5. Know what Bids you Won't Win

6. Know the RFP

7. Have a Value Proposition

8. Build Trust

9. Present the Bid Well

### **Lesson 3: Electrical Systems**

#### **I. Introduction**

A. Background of Electrical Systems

B. Importance of Electrical Systems

#### **II. Fundamentals of Electrical Systems**

A. Components of Electrical Systems

1. Power Sources

2. Conductors

3. Insulators

4. Switches

5. Transformers

B. Electrical Circuits

1. Series Circuits

2. Parallel Circuits

3. Combination Circuits

C. Safety Measures in Electrical Systems

#### **III. Types of Electrical Systems**

A. Residential Electrical Systems

1. Overview

2. Components

3. Wiring

4. Electrical Safety Tips

B. Commercial Electrical Systems

1. Overview

2. Components

3. Distribution Panels

C. Industrial Electrical Systems

1. Overview
  2. Machinery and Equipment
  3. Control Systems
- D. Renewable Energy Systems
1. Solar Power Systems
  2. Wind Power Systems
  3. Hydroelectric Power Systems

#### IV. Specific Examples of Each Type of Electrical System

#### V. Electrical System Design

##### A. Planning and Sizing

1. Load Analysis
2. Voltage and Current Requirements

##### B. Electrical Codes and Regulations

1. National Electrical Code (NEC)
2. Local Building Codes

##### C. Design Software and Tools

##### D. Energy Efficiency in Electrical System Design

#### VI. Installation and Maintenance

##### A. Electrical Installation Procedures

1. Wiring
2. Grounding
3. Circuit Breaker Installation

##### B. Routine Maintenance

1. Inspection
2. Testing
3. Troubleshooting

##### C. Upgrading and Retrofitting

##### D. Safety Practices for Installation and Maintenance

#### VII. Advanced Topics in Electrical Systems

##### A. Smart Grids and Smart Meters

##### B. Energy Storage Systems

##### C. Power Quality and Voltage Regulation

##### D. Electric Vehicle Charging Infrastructure

##### E. Home Automation and IoT Integration

- VIII. Future Trends in Electrical Systems
  - A. Integration of Renewable Energy
  - B. Energy Management Systems
  - C. Electrification of Transportation
  - D. Artificial Intelligence in Electrical Systems

- IX. Conclusion
  - A. Summary of Electrical Systems

## **Lesson 4: Electrical Design and Blueprint Reading**

- I. Introduction to Electrical Design and Blueprint Reading
  - A. Definition and Importance of Electrical Design
  - B. Role of Blueprint Reading in Electrical Design

- II. Fundamentals of Electrical Design
  - A. Electrical Circuits and Components
    - 1. Resistors, Capacitors, Inductors
    - 2. Voltage, Current, and Resistance
  - B. Ohm's Law and Calculations
  - C. Electrical Safety Considerations
    - 1. Codes and Standards
    - 2. Personal Protective Equipment (PPE)

- III. Blueprint Reading Basics
  - A. Introduction to Blueprints and Schematics
    - 1. Symbols and Notations
    - 2. Scale and Dimensions
  - B. Types of Electrical Blueprints
    - 1. Single-Line Diagrams
    - 2. Wiring Diagrams
    - 3. Floor Plans
  - C. Reading and Interpreting Blueprints
    - 1. Identifying Components and Circuits
    - 2. Understanding Legends and Symbols

- IV. Electrical Design Process
  - A. Project Planning and Requirements
  - B. Load Calculations

- 1. Determining Power Requirements
- 2. Voltage Drop Calculations
- C. Equipment Selection and Sizing
- D. Circuit Design and Layout
  - 1. Branch Circuits
  - 2. Distribution Panels
- E. Electrical Load Balancing

- V. Advanced Blueprint Reading
  - A. Three-Phase Systems
  - B. Motor Control Diagrams
  - C. Control Panel Layouts
  - D. Lighting Design and Controls
  - E. Schematic Diagrams for Complex Systems

- VI. Electrical Design Software and Tools
  - A. Introduction to CAD Software
  - B. Using CAD for Electrical Design
  - C. Simulation and Analysis Tools
  - D. Digital Blueprints and Revisions

- VII. Electrical Design Documentation
  - A. Bill of materials (BOM)
  - B. Wiring schedules
  - C. Panel schedules
  - D. As-built drawings
  - E. Documentation standards and best practices

- VIII. Quality Assurance and Testing
  - A. Inspection and Verification
  - B. Continuity and Insulation Resistance Testing
  - C. Commissioning and Startup Procedures

- IX. Electrical Design Case Studies and Examples in the U.S.
  - A. Real-World Electrical Design Projects in the U.S.
  - B. Blueprint Reading Exercises and Practice

- X. Future Trends in Electrical Design
  - A. Smart and Sustainable Design

- B. Integration with IoT and Automation
- C. Energy-Efficient Design Principles

## XI. Conclusion and Summary

- A. Recap of Key Points in Electrical Design and Blueprint Reading

### **Lesson 5: NEC 2023 Article 100 – Definitions**

### **Lesson 6: NEC 2023 Article 110**

#### Outline

#### Article 110 General Requirements for Electrical Installations

##### Part I. General

- 110.1 Scope.
  - 110.2 Approval.
  - 110.3 Examination, Identification, Installation, Use, and Listing (Product Certification) of Equipment.
  - 110.4 Voltages.
  - 110.5 Conductors.
  - 110.6 Conductor Sizes.
  - 110.7 Wiring Integrity.
  - 110.8 Wiring Methods.
  - 110.9 Interrupting Rating.
  - 110.10 Circuit Impedance, Short-Circuit Current Ratings, and Other Characteristics.
  - 110.11 Deteriorating Agents.
  - 110.12 Mechanical Execution of Work.
  - 110.13 Mounting and Cooling of Equipment.
  - 110.14 Electrical Connections.
  - 110.15 High-Leg Marking.
  - 110.16 Arc-Flash Hazard Warning.
  - 110.17 Servicing and Maintenance of Equipment.
  - 110.18 Arcing Parts.
  - 110.19 Light and Power from Railway Conductors.
  - 110.20 Reconditioned Equipment.
  - 110.21 Marking.
  - 110.22 Identification of Disconnecting Means.
  - 110.23 Current Transformers.
  - 110.24 Available Fault Current.
  - 110.25 Lockable Disconnecting Means.
- Part II. 1000 Volts, Nominal, or Less
- 110.26 Spaces About Electrical Equipment.
  - 110.27 Guarding of Live Parts.

110.28 Enclosure Types.  
110.29 In Sight From (Within Sight From, Within Sight).  
Part III. Over 1000 Volts, Nominal

110.30 General.  
110.31 Enclosure for Electrical Installations.  
110.32 Work Space About Equipment.  
110.33 Entrance to Enclosures and Access to Working Space.  
110.34 Work Space and Guarding.  
110.36 Circuit Conductors.  
110.40 Temperature Limitations at Terminations.  
110.41 Inspections and Tests.  
Part IV. Tunnel Installations over 1000 Volts, Nominal

110.51 General.  
110.52 Overcurrent Protection.  
110.53 Conductors.  
110.54 Bonding and Equipment Grounding Conductors.  
110.55 Transformers, Switches, and Electrical Equipment.  
110.56 Energized Parts.  
110.57 Ventilation System Controls.  
110.58 Disconnecting Means.  
110.59 Enclosures.  
Part V. Manholes and Other Electrical Enclosures Intended for Personnel Entry

110.70 General.  
110.71 Strength.  
110.72 Cabling Work Space.  
110.73 Equipment Work Space.  
110.74 Conductor Installation.  
110.75 Access to Manholes.  
110.76 Access to Vaults and Tunnels.  
110.77 Ventilation.  
110.78 Guarding.  
110.79 Fixed Ladders.

## **Lesson 7: NEC 2023 Articles 200-210**

Article 200 Use and Identification of Grounded Conductors

200.1 Scope.  
200.2 General.  
200.3 Connection to Grounded System.  
200.4 Neutral Conductors.  
200.6 Means of Identifying Grounded Conductors.  
200.7 Use of Insulation of a White or Gray Color or with Three Continuous White or Gray Stripes.

200.9 Means of Identification of Terminals.  
200.10 Identification of Terminals.  
200.11 Polarity of Connections.

Article 210 Branch Circuits Not Over 1000 Volts ac, 1500 Volts dc, Nominal  
Part I. General

210.1 Scope.  
210.2 Reconditioned Equipment.  
210.3 Other Articles for Specific-Purpose Branch Circuits.  
210.4 Multiwire Branch Circuits.  
210.5 Identification for Branch Circuits.  
210.6 Branch-Circuit Voltage Limitations.  
210.7 Multiple Branch Circuits.  
210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.  
210.9 Circuits Derived from Autotransformers.  
210.10 Ungrounded Conductors Tapped from Grounded Systems.  
210.11 Branch Circuits Required.  
210.12 Arc-Fault Circuit-Interrupter Protection.  
210.13 Ground-Fault Protection of Equipment.  
210.17 Guest Rooms and Guest Suites.  
Part II. Branch-Circuit Ratings

210.18 Rating.  
210.19 Conductors — Minimum Ampacity and Size.  
210.20 Overcurrent Protection.  
210.21 Outlet Devices.  
210.22 Permissible Loads, Individual Branch Circuits.  
210.23 Permissible Loads, Multiple-Outlet Branch Circuits.  
210.24 Branch-Circuit Requirements — Summary.  
210.25 Branch Circuits in Buildings with More Than One Occupancy.  
Part III. Required Outlets

210.50 Receptacle Outlets.  
210.52 Dwelling Unit Receptacle Outlets.  
210.60 Guest Rooms, Guest Suites, Dormitory Units, and Similar Occupancies.  
210.62 Show Windows.  
210.63 Equipment Requiring Servicing.  
210.65 Meeting Rooms.  
210.70 Lighting Outlets Required.

**Lesson 8: 2023 Articles 215-220**

Article 215 Feeders

215.1 Scope.  
215.2 Minimum Rating and Size.

- 215.3 Overcurrent Protection.
- 215.4 Feeders with Common Neutral Conductor.
- 215.5 Diagrams of Feeders.
- 215.6 Feeder Equipment Grounding Conductor.
- 215.7 Ungrounded Conductors Tapped from Grounded Systems.
- 215.9 Ground-Fault Circuit-Interrupter Protection for Personnel.
- 215.10 Ground-Fault Protection of Equipment.
- 215.11 Circuits Derived from Autotransformers.
- 215.12 Identification for Feeders.
- 215.15 Barriers.
- 215.18 Surge Protection.

## Article 220 Branch-Circuit, Feeder, and Service Load Calculations

### Part I. General

- 220.1 Scope.
- 220.3 Other Articles for Specific-Purpose Calculations.
- 220.5 Calculations.

### Part II. Branch-Circuit Load Calculations

- 220.10 General.
- 220.11 Maximum Load.
- 220.14 Other Loads — All Occupancies.
- 220.16 Loads for Additions to Existing Installations.

### Part III. Feeder and Service Load Calculations

- 220.40 General.
- 220.41 Dwelling Units, Minimum Unit Load.
- 220.42 Lighting Load for Non-Dwelling Occupancies.
- 220.43 Office Buildings.
- 220.44 Hotel and Motel Occupancies.
- 220.45 General Lighting.
- 220.46 Show-Window and Track Lighting.
- 220.47 Receptacle Loads — Other Than Dwelling Units.
- 220.50 Motors and Air-Conditioning Equipment.
- 220.51 Fixed Electric Space Heating.
- 220.52 Small-Appliance and Laundry Loads — Dwelling Unit.
- 220.53 Appliance Load — Dwelling Unit(s).
- 220.54 Electric Clothes Dryers — Dwelling Unit(s).
- 220.55 Electric Cooking Appliances in Dwelling Units and Household Cooking Appliances Used in Instructional Programs.
- 220.56 Kitchen Equipment — Other Than Dwelling Unit(s).
- 220.57 Electric Vehicle Supply Equipment (EVSE) Load.
- 220.60 Noncoincident Loads.
- 220.61 Feeder or Service Neutral Load.
- 220.70 Energy Management Systems (EMSs).

#### Part IV. Optional Feeder and Service Load Calculations

220.80 General.

220.82 Dwelling Unit.

220.83 Existing Dwelling Unit.

220.84 Multifamily Dwelling.

220.85 Two Dwelling Units.

220.86 Schools.

220.87 Determining Existing Loads.

220.88 New Restaurants.

#### Part V. Farm Load Calculations

220.100 General.

220.102 Farm Loads — Buildings and Other Loads.

220.103 Farm Loads — Total.

#### Part VI. Health Care Facilities

220.110 Receptacle Loads.

#### Part VII. Marinas, Boatyards, Floating Buildings, and Commercial and Noncommercial Docking Facilities

220.120 Receptacle Loads.